The Biology of the Benthopelagic Component of the Shallow Scattering Layer

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LONG-TERM GOALS

Each night, large numbers of animals (particularly crustaceans) swim out of the seabed into the water column, a phenomenon termed "emergence." The distribution of these optical and acoustic scatterers is not well known in time and space. The cues that trigger the behavior, the environmental factors that modulate it, and the underlying ecological mechanisms that drive it are just beginning to be elucidated. My long-term goal is to understand this phenomenon to the point that variation in space and time are predictable and mechanistically understood.

OBJECTIVES

My main objective during this funding cycle was to test the subsystems of an isokinetic sampler that will allow me to collect small (0.3–30.0 mm), emerging animals quantitatively from multiple heights simultaneously at short time intervals. Such a sampler will be a key tool for the study of the spatiotemporal variability of emergence. My second objective was to analyze and write up the results of my study of the ecology of the small emergers at the site studied during the SAX99 experiment of the Benthic Acoustic DRI.

APPROACH

My approach to the design of the isokinetic sampler was (1) to determine the constraints that the biology imposed (for example, the volume of a sample must be large enough to collect sufficient animals for statistical tests), (2) to consult with a fluid dynamicist about design criteria for isokinetic sampling, (3) to prepare construction drawings (with help from a Senior Design Team from the FSU College of Engineering), (4) to arrange for the construction of prototype subsystems by a machinist in the FSU Department of Oceanography, (5) to test these subsystems, and (6) to test a complete unit.

My approach to the investigation of the small emergers at the SAX99 study site was to perform an emergence-trap experiment when the Benthic Acoustics DRI investigators were on the site. With these samples, a graduate student (Linda Gensel) and I have determined which species emerge and have tested for differences in emergence from ripple crests and troughs to begin the study of cm-to-m-scale spatial variability in emergence. We also plan to search for commonalities among emergers that might be used to predict the identities of emergers in other environments.

WORK COMPLETED

During FY 2002, a Department of Oceanography machinist fabricated each of the subsystems of the new sampler. The pumping system, the sampling system, the intake-head assembly, and the supporting structure were tested in the ocean and small refinements were made.

During FY 2002, the student analyzed the SAX99 emergence-experiment data and wrote a draft of her master's thesis in the form of a manuscript for publication.

RESULTS

The development of the isokinetic sampler is nearly complete. Each subsystem has been tested and refined. The machinist will complete the remaining fabrication during fall 2002. I anticipate a sea trial in December 2002. All indications are that the new sampler will work as anticipated.

The major results of the SAX99 emergence experiment include the following. (1) Small animals emerge in abundance in the high-energy environment of the SAX99 site, so their emergence is not a phenomenon of slow-flow environments as had been suggested. (2) Previous workers have tended to view the emergence of a species as an all-or-nothing phenomenon. The SAX99 results show that emergence rate (percent that emerge in 24 hrs) of species can vary from 2% to 100% (Figure 1). That different species emerge in very different proportions suggests that a single mechanism does not underlie the phenomenon. (3) Percent emergence for 25% of the species differs significantly between troughs and crests of sediment ripples, indicating that emergence is not spatially homogeneous and can be modified by environmental features (Figure 1).

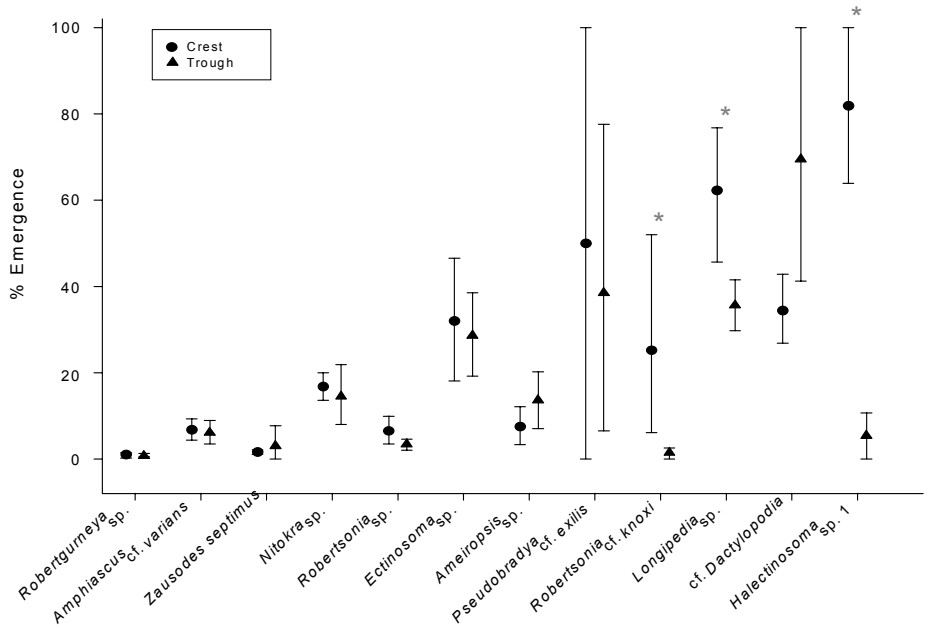

Figure 1. This graph shows that benthic copepod species at the SAX99 study site emerged in percentages that varied from 2% to 100% and that percent emergence of three species differed significantly between ripple crests and ripple troughs. Asterisks indicate significant differences. Error bars are 95% confidence intervals.

IMPACT

The development of an isokinetic sampler scaled for use with <30-mm animals will be of great value in the study of emergence, but it should also be of use to students of other organisms in this size class, e.g. the larvae of benthic animals.

The discovery that topographic heterogeneity affects emergence implies that such heterogeneity should be considered in the design of future sampling schemes. Also, the reasons for differences in response of species to topographic heterogeneity will need to be investigated.

RELATED PROJECTS

Dr. Peter Jumars is also studying emergence in the context of the Benthic Acoustics Initiative. He is concerned with larger emergers, which are taxonomically distinct and must be sampled with different techniques. We are working closely together to coordinate fieldwork and to share ideas about the emergence phenomenon.